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ABSTRACT

The relationship between departmental activities and the need for nonacademic staff and operating funds was analyzed using regression analysis. Support costs were broken into task categories and related to certain basic variables describing the composition and activity of the unit (e.g., number of staff and teaching load). The results were linked in a model that predicts the costs for departmental support based on institutional activity variables, such as number of fields of study, number of students, and number of teaching and research staff. For each academic unit, required operating funds and the total number of nonacademic staff (expressed in full-time equivalents) needed for task categories were calculated. Staff activities and expenditures were broken down for both teaching and research functions. The nonacademic staff in an academic unit that has teaching and research activities were considered to involve the two main categories of clerical and technical staff. Equations for the different areas of analysis, and operating and general expense categories are presented. Study data were primarily based on the Flemish University of Brussels. (SW)

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AN ANALYSIS OF THE NEEDS FOR NON-ACADEMIC STAFF AND OPERATING FUNDS IN A UNIVERSITY.

by

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Mary Corcoran
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(Editor, AIR Forum Publications)

ABSTRACT.

Regressions can be used to analyze the relationship between departmental activities and the need for non-academic staff and operating funds. Support costs are broken into task categories and related to certain basic variables describing the composition and activity of the unit (e.g. FTE academic staff, teaching load). The results are then linked in a total model which predicts the costs for departmental support based on institutional activity variables such as number of fields of study, number of students, number of teaching and research staff. The model is generalizable to many national settings.

1. INTRODUCTION.

The connection between the teaching load in a university and the requirements for academic staff are well understood. Several realistic models have been set up and some of them are actually in use for effective resource allocation : (see e.g. Hussain-Gulko [1971], Hussain [1977]).

The other departmental expenditures, namely non-academic staff and working expenses, have been the object of much less investigation. Either they are studied on a very aggregated level, like in Verry-Davies (1976) and are related to coarse variables like number of students and field of study. Or else they are described by a rudimentary model based on a priori rules that, although reasonable, were never thoroughly compared with real life situations, (see Dunworth [1975] and Hussain [1977]). The results are not convincing enough to become widely used in university management.

This study aims at constructing a model of these support expenditures, that is realistic enough to be of practical use. More specially we sought for a number of quantitative characteristics of the producing units of the final outputs of a university that determine their requirements for administrative and technical staff and for operating funds.

This model has several purposes. First it should be of help for resource allocation inside a university. Without being normative, it should give a comparison standard to evaluate the adequacy of the means that have been granted and be realistic enough to give a sound base of discussion between the departments and the management of the university.

On the other hand the model should be useful for longer term resource planning. It must evaluate with enough accuracy the means that are necessary to achieve a modification of the outputs of a university. The teaching outputs are well understood and easy to quantify. The same cannot be said of the research outputs. They have first to be translated in quantifiable activities and then the research output can be described by some primary measure of the research activities, like e.g. the FTE number of academic research positions.

Finally this model is part of a more complete model of university expenditures, that looks for a realistic description of them in terms of a small set of reliable and relevant independent variables. There has been a tendency to consider that the grants of a university should be determined only by the number of students (and often, in direct proportion to it). It is clear to many persons that this is a too simplistic criterion. It is not so clear what other quantities can be introduced to give a broader basis for the calculation of the recurrent grant for the universities.

The academic hospital has been kept out of this study. Its working expenses are legally completely separated from those of the university and there is another study going on covering this topic.

2. *A SHORT DESCRIPTION OF THE FLEMISH UNIVERSITY OF BRUSSELS.*

Since for this study most data come from our own university, it is necessary to describe it briefly for a good comprehension of what follows.

The flemish university of Brussels (in short V.U.B.) is a rather small university (5.200 students) that is self governing since 1970. Previously it was part of an older university that had become completely bilingual since the sixties. It includes the usual disciplines from the humanities and law to medecine and engeneering, and that to level of bachelor's and doctoral degree.

It is not organized in departments, but in faculties (seven in number) and inside the faculties in smaller units, that correspond to a chair in german universities. They have a large autonomy, are usually headed by a full-time professor and comprise usually no other person of professioral level but scientific staff, that is graduating or has already a doctorate. These units are the smallest effective cost centres in the academic sector. They will be called academic units (in french : unité élémentaire d'enseignement et de recherche - see e.g.Cossu, Cunnin, Babeau [1974, P.10]). Some of these units are essentially teaching oriented, some have chiefly research activities, with a continuous spectrum in between.

The incomes of the university - for what is of interest for us - come chiefly from two kind of sources. First a grant of the ministry of education, that is proportional to the number of students subdivided in three categories (roughly human sciences, pure sciences and special schools - engineering and medicine). On the other hand research grants from varied sources. These cover expenses for scientific staff, non-academic staff, working expenditures and eventually for scientific equipment, but never contribute to professioral wages. Consulting and other renumerated supplyings to third parties are marginal at the V.U.B. and have been neglicted in this study.

3. METHODOLOGY AND APPROACH.

Instead of investigating the total numbers of non-academic staff and the total amount of working expenses, per academic unit, like has been done by Verry et al (1976), we have tried to decompose the activities of staff and the expenditures into significant components that are more or less obviously related to some basic variables pertaining to in teaching or research.

This procedure is in a certain sense analogous to that used for academic staff, whose activities one decomposes int. teaching, research and others and for which the teaching activities can be quantified in an explicit way in function of the teaching load.

For non-academic staff and working expenses, the situation is much less clearcut, because the above categories are to crude to sustain a further analysis. We took a hint from a study of Utrecht University in the Netherlands (Van Noord, 1976), where, for other purposes, they noticed that it was more relevant to study the time spent on a given task in a department than the number of staff it self.

We used the same principle and decomposed for each academic unit, the total number of non-academic staff, in numbers of full-time equivalents (FTE) of staff needed for several tasks, or rather for taskcategories. Analogous methods were used for the working expenses.

Then we tried to relate each piece to basic variables, describing the research and teaching activities of the unit. These variables are fairly standard for teaching. As there exist as yet no convincing measures of research output, we were obliged to use input-based quantities, such as the research time in FTE man-years of academic staff, as variables for research. The basic hypothesis that underlies this procedure is that usually the granting authoriti s measure their support in function of the results achieved by the research team and one has a good approximation by assuming that research output is highly correlated to research grants and so to research activities.

We used standard econometric methods like regression analysis and techniques of descriptive statistics. We restricted the model to linear relationships because we did not dispose of enough relevant data to warrant non linear models. Also we wanted to keep the final results simple enough to make of it a manageable tool for planning and resource allocation purposes.

This procedure gave for each task- or expense category a linear function in the most appropriate independent variables. This resulted in a set of linear equations using many different quantities. To simplify the final formules we replaced closely related variables by a single one. The regressions per category were then repeated using these smaller set of basic variables.

The study was first carried out for the non-academic staff, and afterwards for working expenses because it is reasonable to assume that the causality goes from staff to expenses. This is not completely true (see the clerical staff) but finally the variables can be ordered so that each can be computed in terms of previous variables.

4. DATA SOURCES.

In this study the only data available to us with enough detail and with the possibility of crosschecking in case of doubt were these of our own institution. They came from several sources, in the first place from the financial system but also from the existing data-bank of teaching activities.

Due to the amount of data we had to ressort to computer based statitical techniques. We used the well-known "Statistical Package for the Social Sciences" (SPSS). We had to organise a data base compatible with SPSS. The final data-base was in fact a combination of partial data-bases, linked with computer programs. Each of them contained informations about specific categories of resources or activities.
The following partial data-bases were used :

a) data-base "STAFF" provided the system with detailed information about the staffing of each academic unit.
b) data-base "EXPENDITURES" : the input-file contained a great number of expense categories. In a first stage we aggregated them to more relevant categories, so that the information became more easy to analyse.
c) data-base "INVENTORY OF SCIENTIFIC EQUIPMENT" contained all informations concerning the value and the composition of the laboratory equipment in experimental units.
d) data-base "TEACHING ACTIVITIES" as to this category of information, we were obliged to create a total new data-base, in which the teaching activities of each member of academic staff were recorded. As each member of teaching staff belongs to one academic unit, it was possible to calculate some basic variables such as total hours of lecturing or, total number of student-hours practical work in laboratories per academic unit.

5. *CLASSIFICATION OF UNITS.*

As academic units have different kinds of research and teaching activities, there will occur differences into the structure of their expenditures and requirements for non-academic staff. For certain expense components, one is obliged to treat one group of units in a different way than other groups.

Before starting the study, we made an a priori classification of academic units based on the field of study and the composition of the laboratory equipment. As the analysis concerning the support expenses evolved, we modify this grouping by taking into account the pattern of their working expenses.

This resulted in the following classification :

a) NON-EXPERIMENTAL UNITS
   a1) no scientific equipment
   a2) units having a non negligible stock of equipment

b) EXPERIMENTAL UNITS
   b1) chemistry
   b2) biochemistry
   b3) molecular biology
   b4) classical biology and ecology
   b5) medicine
   b6) physics
   b7) engineering

As the study evolved we made another division of the academic units between teaching-oriented and research-oriented units. A unit was considered to be research-oriented if the funding of its research-activities occured chiefly through grants coming from public or private institutes.

6. NEEDS FOR NON-ACADEMIC STAFF.

6.1 METHODOLOGY.

The non-academic staff in an academic unit, having teaching- and research activities consists of two main categories :

a) clerical staff
b) technical staff

For each of these main categories we made a seperate analysis. In a preliminary inquiry we recorded all different tasks of staff and aggregated these in relevant taskcategories. This was fairly easy for the clerical staff, but presented some difficulties for the technical staff.

For the clerical staff following important taskcategories emerged :

- support of teaching activities
- support of research activities
- administration of operating funds
- administration of the unit and contacts with faculty and central administration

For the technical staff we made following classification :

- support of teaching activities (technical assistance in teaching laboratories and assistance to post-graduate students making an experimental junior-thesis)
- maintenance of research-equipment and running certain categories of research apparatus
- administrative tasks (e.g. management of stock of chemical products, placing orders, ect.)

All members of staff were asked for the time spent on each taskcategory. Inside each category they had to point to the tasks they performed mostly. This gave often interesting clues for the later analysis. Summing over all members of staff one gets in this way for each academic unit the FTE number of staff used for each taskcategory. These were the quantities submitted per category to regression analysis. Although the answers to the inquiry were rather crude, the final results are satisfactory, principally for the clerical staff.

6.2 RESULTS OF THE CLERICAL STAFF MODEL.

Here we summarize the variables, which explained best the magnitude of the number of staff required for each activity.

6.2.1 Support of teaching activities.

The number of clerical staff required for teaching activities was fairly well correlated with the number of hours for exercise sessions, attended by a large number of students - this means by more than 30 students - (denoted by UGG). The regression coefficients for exercise sessions, given to small groups, and for hours of lectures were not reliable, and were in fact not significantly different from zero.

6.2.2 Administrative support of research activities.

We obtained the best relationship with the number of academic staff, allocated to research-activities (*RESPE*) as independent variable, which is defined as the sum of all research-time of each member of academic staff, expressed in FTE man-years.

6.2.3 Administration of operating funds accounts

Every unit receives, either from the university or from non-university bodies grants to finance the operating costs of the unit. Besides the general grant - meant for educational purposes - a unit will have one or more accounts for each research project. The control of incomes and expenditures is one of the tasks of a secretary. The time of staff for this activity was very well correlated with the total amount of operating funds received (*OPF*).

6.2.4 General administration of the unit

An academic unit maintains relations with other university bodies such as faculties and central administration. The time spent on these tasks appeared to be about constant for all units.

6.2.5 Conclusion

The theoretical staff required in an academic unit (ADM_{TOT}) was determined by simple summoning the different equations.

$$ADM_{TOT} = 0.30 + 0.001027\ UGG + 0.05\ RESPE + 0.000183\ OPF$$

An examination of the residuals did not give any new significant difference between categories of academic units.

Notice that all financial variables are expressed in belgian currency, this will also be the case in what follows.

6.3 NEEDS FOR TECHNICAL SUPPORT : RESULTS

We used the same methodology as for the analysis for clerical support. In general we did not observe significant differences between categories of units, except for the support of research activities.

6.3.1 Assistance to teaching activities

The number of staff required for teaching tasks was fairly good correlated with the number of student-hours of practical laboratory work (*STUL*) and the number of post-graduate students making an experimental junior-thesis (*THES*).

6.3.2. Support for research activities

A first investigation indicated the units in physics to be deviant from the other experimental categories. So we made seperate analysises for the physical academic units and the units belonging to other categories. Fairly good correlations were observed with the number of FTE research staff (*RESPE*) and the stock of scientific equipment (*LABEQ*) for the "other categories". As to the physics the coefficient for equipment was not significantly different from zero.

6.3.3 Administrative tasks of technical staff

Experimental units of different categories may have considerable quantities of laboratory products in stock. We introduced a dummy variable (*SP*), that could only have the values one - in which case there was a considerable stock of products - and zero - if there was no significant stock to control.

As to the other administrative activities, a good relationship was observed with the total amount of operating funds.

6.3.4 Conclusion

As in 6.2.5 the total theoretical technical support (TEC_{TOT}) was determined by summoning the several partial equations. We got two different equations, one for the units of physics and another for units belonging to other categories :

- physics :

$$TEC_{TOT} = 0.51 + 0.00103\ STUL + 0.08\ THES + 0.224\ RESPE + 0.000138\ OPF + 0.10\ SP$$

- other experimental units :

$$TEC_{TOT} = 0.58 + 0.00103\ STUL + 0.08\ THES + 0.201\ RESPE + 0.1040 \cdot 10^{-6} \cdot LABEQ + 0.000138\ OPF + 0.10\ SP$$

In some partial analysises the number of academic units which were brought into the calculations was rather small; in that case the confidence intervals for the regression coefficients became large and the coefficients less reliable.

7. OPERATING FUNDS.

7.1 METHODOLOGY.

The financial system provided us with the amount of expenditures of each academic unit split up according to rather detailed expense categories and to the income source. In fact every unit has a general operating fund, were the expenses for teaching are taken from, and eventually specific research funds coming either from the university or other sources, were no teaching expenses are allowed. Since no difference is made in the accounts between teaching and research expenses, we could at least locate these first expenditures in a substansially smaller amount than the total expenditures.

The expense categories were aggregated into larger more relevant rubrics. For that purpose we computed the correlation matrix between the different detailed expense categories. Highly correlated categories were put together. Finally following expense categories were retained :

a) general expenditures (W1) consisting of
   - office supplies (stationary, photo-copies, paper)
   - communication costs (phone, stamps, telex)
   - congress and travelling expenses
   - maintenance of office equipment
   - books, periodicals, costs of publications

b) laboratory expenditures (W2) consisting of
   - maintenance and repairs of scientific equipment, small equipment and materials
   - chemical products and biological supplies

In general we used the 1978-figures but only for, those expenditures categories that were stable from year to year. This we checked by computing the correlation between those expenditures of the last three years for which complete data were available. When the correlations between the expenditures from one year to another were too low, we considered the average expenses as being more reliable.

7.2 RESULTS FOR THE GENERAL EXPENSES.

7.2.1 General office supplies

Because these expenditures are connected to teaching as well as to research activities, we related them to both variables of research and teaching. As to the teaching factor we observed a strong relationship with the number of student-hours of exercises attended by many students (*STUGG*). The exercises given to smaller groups did not appear to be a relevant variable. As to the research-factor, we were forced to include two variables (*APRES1* and *APRES2*) related to the FTE academic research staff variable, and of which the values were different for research-oriented and teaching-oriented units.

7.2.2 Communication costs, congress and travelling expenses

These kinds of expenditures are chiefly related to the research activities of a unit. Because they appeared to be very instable as a function of time, we calculated the mean expenditures for three years. This mean was considered as dependent variable and has been related to the academic research variable (*RESPE*). As in the foregoing analysis better results were obtained by making a difference between teaching-oriented and research-oriented units.

7.2.3 Maintenace of office equipment

We could not investigate the relationship with the value of office equipment, because we did not have reliable information concerning this variable at the moment of the study, but a good relationship was observed with the number of secretaries (*SEKR*).

7.2.4 Books, periodicals, costs of publications

Regression analysises made with all possible relevant variables of research and teaching did not lead to acceptable results. Upon closer examination one could observe significant differences between units of different research-fields. Within a same group, however the expenditures per professor were rather constant.

So we calculated the total value of purchases for units belonging to the same research-field-category, and divided the result by the total number of professors (*RESP1*). The resulted coefficient a_α was different for each field of study α.

7.2.5 Conclusion

The total administrative support costs were determined by simple summoning the partial equations (notice that all financial variables are expressed in belgian currency) :

$$WI = 19050 + 22630\ APRES1 + 16100\ APRES2 + 2.2\ STUGG + 6400\ SEKR + a_\alpha\ RESP1$$

No significant differences were observed between experimental and non-experimental academic units. But the classification in teaching-oriented and in research-oriented helped to explain in a significant way variations in the amount of expenses between units.

7.3 LABORATORY EXPENDITURES

Maintenance and repaircosts of labequipment and purchases of chemical products or biological supplies are made for teaching as for research purposes. As teaching costs are only a small fraction of research costs, for these categories of expenditures, we obtained very unstable coefficients, whenever a student-related variable was introduced in the analysis. In some cases, however, one could determinate the expenses directly related to teaching by seperating the general fund from the research funds and relate the first to variables describing the teaching laboratory activities.

Moreover after an examination of residuals we observed large differences between some categories of units. In both cases clinical units had to be analyzed seperately. The units of molecular biology could be treated together with the clinical ones.

7.3.1 Maintenance and repairs of scientific equipment, purchases of small equipment and materials

We obtained the best results when making seperate calculations for two categories of units :

a) medicine and molecular biology (b5, b3)

b) other experimental units (b1, b2, b4, b6, b7)

For the "other experimental units", we first related the expenses coming from the general fund to the total value of scientific equipment (*LABEQ*) and all obvious variables, related directly or indirectly to teaching activities. The results were not satisfactory, so we made a regression between the total expenses (independent variable), the total academic research staff and scientific equipment (independant variables).

As to medicine and molecular biology; it was possible to relate the expenses coming from the general fund to the academic research staff paid by the university. Expenses on research grants were fairly well correlated with the number of research assistants paid on contracts (*RESP22*) and the value of labequipment.

7.3.2 Chemical products and biological supplies

After a first examination of the figures we were able to distinguish four categories of units for which seperate analysises were made :

a) medicine and molecular biology (b5, b3)

b) chemistry and biochemistry (b1, b2)

c) classical biology and ecology (b4)

d) physics and engineering (b6, b7) no expenses

As to the classical biology we did not have enough observations to make a thorough analysis.

For categories a and b, we split up the total expenditures in general fund and research grants. We obtained the best results relating the general fund to the number of technical staff (*TEC*) and the lab-student-hours (*STUL*), and relating the research grants to the variables *TEC* and *RESP22*.

7.3.3 Conclusion

The extra costs for an experimental unit, are function of the experimental category to which it belongs. Taking into account 7.3.1 and 7.3.2 we found different equations for the following experimental categories :

a) physics and applied sciences

$$W2 = -11300 + 18800\ RESP21 + 18800\ RESP22 + 0.0118 \cdot 10^{-6} \cdot LABEQ$$

b) chemistry and biochemistry

$$W2 = -33500 + 18800\ RESP21 + 56200\ RESP22 + 32200\ TEC + 0.0118 \cdot 10^{-6} \cdot LABEQ + 1.2\ STUL$$

c) medicine and molecular biology

$$W2 = 164000 + 82000\ RESP21 + 43100\ RESP22 + 54000\ TEC + 0.0125 \cdot 10^{-6} \cdot LABEQ + 5.6\ STUL$$

Physics and applied sciences appeared to be the cheapest units, because they have almost no expenses for chemical products and biological supplies.

As to the classical biology and ecology we could not calculate a global formula, because we did not have enough observations concerning purchases of chemical products and biological supplies.

The constant term of the equation for chemistry and biochemistry was significantly not different from zero. The constant term and the coefficients for *RESP21*, *TEC* and *STUL* were significantly higher for medicine and molecular biology compared to chemistry and biochemistry; wheras the other coefficients - for scientific apparatus and research assistants paid on contracts - were about the same.

8. CONCLUSION.

The constructed model evaluates the needs for non-academic staff and operating funds to a number of basic variables related to the teaching and research activities of academic units. This model has the merit of being based on empirical evidence and not on a priori consideration, that look very reasonable at first sight, but after closer examination do not correspond to reality. Although specific to one university, it carries over to many other institutions that have an analogous structure. The method can be helpful still in a wider context.

It gives a broader set of criteria than usual to base the allocation of various resources inside the university. They are diversified enough to take many different situations into account and are easy to use. Being directly related to the activities of the academic units, the model uses variables that are easy to evaluate in changing circumstances and it is for this reason very useful for planning purposes, at least as long as the basic variables do not change too drastically due to its linear character.

Finally it appears that the majority of departmental costs are not directly proportional to the number of students, what is inconsistent with usual opinion, but are usually related to it in a more complicated way and depend also on other factors.

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